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ACTIVITY DENSITY OF SOIL FAUNA IN CULTIVATED LANDS OF MIDDLE EGYPT.

I. - SOIL MESOFAUNA ASSOCIATED WITH MIXED FRUIT TREES

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ABSTRACT

This study investigates the activity density of soil fauna in an orchard of mixed fruit trees at Beni-Suef Governorate, Middle Egypt. Samples were collected during the period between February and November 1995 by means of the pitfall trap method. Data were treated by the advanced multivariate statistical methods, correspondence analysis and ascending hierarchic classification. Results obtained show that the most dominant species in the study area and period were *Pheidole* sp. and *Monomorium* sp. (Hymenoptera), Collembola and Tephretidae (Diptera). The trophic (functional) groups of the total fauna were equitably represented, and were affected by the mosaic pattern of cultivation practiced in the area.

INTRODUCTION

The composition and diversity of soil animals may differ in agro-ecosystems according to cropping patterns and type (Perfecto and Sediles, 1992), intensity of agricultural practices (Swift et *al.*, 1996), the complex influence of site and cultivation specific parameters (Mikhail and Hussein, 1997) and the mosaic pattern of cultivation (Hussein and Mikhail, 1998). All these factors appear to create a rather accidental pattern of soil mesofauna frequencies in agro-ecosystems (Mikhail and Hussein, 1997; Hussein and Mikhail, 1998). These factors will also affect the densities and pattern of the distribution of the three main trophic (functional) groups: herbivores, detritivores and carnivores, among soil animals (Ghabbour, 1991; Mikhail and Hussein, 1997; Hussein and Mikhail, 1998).

The present work is designed to investigate the community structure of soil fauna as well as the three main trophic groups in mixed fruit trees in Bayad

El-Arab, Beni-Suef Governorate, Middle Egypt, in relation to fruit tree type and the pattern of cultivation practiced in the area.

MATERIAL AND METHODS

The study area and crops

The study comprises the investigation of the activity density of the total soil mesofauna as well as the main functional (trophic) groups (herbivores, detritivores and carnivores) associated with an orchard of mixed fruit trees at the area of Bayad El-Arab, Beni-Suef Governorate, Middle Egypt. The orchard trees were: guava (*Psidium guajava*), mango (*Mangifera indica*), sour orange (*Citrus aurantium*), mandarin (*Citrus reticulata*), fig (*Ficus carica*), pear (*Pyrus communis*), apple (*Pyrus malus)*, and apricot (*Prunus armeniaca*). This investigation was carried out during the period between February to November 1995.

Method of sampling soil mesofauna

The soil mesofauna were collected from the study area by the pitfall trap method as described by Southwood (1978) and Slingsby and Cook (1986). In this method, the number of individuals trapped is primarily dependent on their locomotory activity (Greenslade and Greenslad, 1983; Kromp, 1990; Mikhail, 1993). These are called activity densities rather than population densities (Kromp, 1990; Mikhail, 1993; Mikhail *et al.*, 1995; Mikhail and Hussein, 1997; Hussein and Mikhail, 1998).

Twenty pitfall traps were used monthly during the study period.

Statistical analysis:

Data of the activity density of the soil fauna were analyzed by advanced multivariate statistical methods: correspondence analysis CA (Greenacre, 1984) and ascending hierarchic classification AHC (Roux, 1985). The computer calculations for CA and AHC were carried out in Cairo University using DATAVISION programme 1.2 (Roux, 1987) developed for APPLE IIe in BASIC.

RESULTS

A total of 69 species and/or higher taxa of soil fauna were collected in the present investigation. The numbers of taxa of soil fauna varied among the fruit trees (Table 1). The pear fruit tree had the highest number (54) of soil fauna taxa. The fruit trees in descending order were: apricot (34), apple (31), mandarin (27), mango (26), guava (25), sour orange (23) and fig (21).

Figure 1 shows results of the application of CA and AHC techniques to the data of activity density of soil fauna (Table 1) associated with the mixed fruit trees of the present investigation, in order to study the horizontal distribution of soil fauna with each individual fruit tree. Thirty-two percent of the total variance is associated with the first (horizontal) axis and 25% with the

second (vertical) one. The first axis separates the soil fauna associated with apricots from the rest of the cultivated trees. The apricot group contained more or less 17 soil fauna taxa. These taxa were: Araneida, Staphilinidae and other Tenebrionidae (Coleoptera), Anthomyiidae, Fanniidae, Muscidae, Phoridae, Tachinidae and Sarcophagidae (Diptera), *Parasarcophaga* sp. (Diptera, Sarcophagidae), *Oligotoma* sp. (Embioptera, Oligotomatidae), Heteroptera, Aphidiidae (Homoptera), *Camponotus* sp. (Hymenoptera, Formicidae), Myrmeleontidae larvae (Neuroptera), Trichoptera and Isopoda. A group of 14 taxa of soil fauna were associated with guava fruit trees. These taxa were: *Zophosis* sp. (coleoptera, Tenebrionidae), Chironomidae, Chloropidae, Pipunculidae and Tephretidae (Diptera), *Sciaria* sp. (Diptera, Sciaridae), Cercopidae and Cicadellidae (Homoptera), Braconidae and Chalcididae (Hymenoptera), *Cardiocondyla* sp., *Cataglyphes* sp. and *Paratrechina* sp. (Hymenoptera, Formicidae) and Orthoptera. Six fruit trees were similar to each other in their soil fauna composition. These fruit trees were mango, pear, apple, sour orange, fig and mandarin. This group was characterized more or less by Acarina, Collembola, Coleoptera, Elateridae (Coleoptera), *Culex pipiens* (Diptera, Culicidae), Dolichopodidae (Diptera), Bethyloidea (Hymenoptera), *Monomorium* sp. and *Pheidole* sp. (Hymenoptera, Formicidae), *Vespa orientalis* (Hymenoptera, Vespidae) and Acrididae (Orthoptera). *Musca domestica* (Diptera, Muscidae) and Psychodidae (Diptera) were associated with both the apricot group and the six fruit trees group. Buprestidae and Scarabaeidae (Coleoptera), Otitidae (Diptera), Hymenoptera and Gryllidae (Orthoptera) were associated with the guava shrub group but at very low numbers. A group of 19 taxa of soil fauna was associated with both the guava tree group and the six fruit trees group. These taxa were: *Anthicus* sp. and *Notoxus* sp. (Coleoptera, Anthicidae), *Sitophilus* sp. (Coleoptera, Curculionidae), *Pentodon* sp. (Coleoptera, Scarabaeidae), *Blaps* sp. (Coleoptera, Tenebrionidae), Labiduriidae (Dermaptera), Calliphoridae, Lauxaniidae, Sepsidae and Sphaeroceridae (Diptera), *Syrphus corollae* (Diptera, Syrphidae), *Psilocephala freunfeldi* (Diptera, Thereviidae), Tetratembiidae (Embioptera), Formicidae (Hymenoptera), *Ponera* sp. and *Solenopsis* sp. (Hymenoptera, Formicidae), Pompilidae and Sphecidae (Hymenoptera) and Chrysopidae larvae (Neuroptera).

Figure 2 shows the results of the breakdown of the soil fauna into the three main trophic (functional) groups: herbivores, detritivores and carnivores. Generally, the three trophic groups were equitably represented in the eight fruit trees of the present investigation. Herbivores were the most abundant group and higher in the case of apple, pear and fig, medium in apricot and mango and lower in sour orange, mandarin and guava. Detritivores were slightly higher in the case of fig and nearly the same in the other fruit trees. Carnivores were

slightly higher in apricot, fig, sour orange, and mango and slightly lower in pear, apple, guava and mandarin.

DISCUSSION

In the present investigation, the fruit trees cultivated were mango, pear, apricot, apple, sour orange fig, guava and mandarin. This leads to marked differences in numbers of species and/or higher taxa sampled from either the above mentioned fruit trees. On the other hand, the intensity of agricultural practices were minimum in the case of these fruit trees cultivated in the area of Bayad El-Arab at Beni-Suef Governorate. Generally, these fruit trees contained a high number of species. In other agro-ecosystems, agricultural practices were maximum, they contained lower number of species (Mikhail and Hussein, 1997; Hussein and Mikhail, 1998).

The study of trophic (functional) groups among the populations of soil fauna was important in order to evaluate the structural composition of these groups in different ecosystems (Ghabbour, 1991) and illustrate the degree of complexity of food chains occurring in such agro-ecosystems (Mikhail and Hussein, 1997; Hussein and Mikhail, 1998). In the present study, the three main trophic groups: herbivores (potential agricultural pests), detritivores (essential for biological soil fertility) and carnivores (natural enemies of herbivores), are well represented under all fruit trees. These results suggest that there are complex food chains in the investigated fruit trees. This phenomenon was found associated with potato cultivations (Mikhail and Hussein, 1997) and tuber crops (Hussein and Mikhail, 1998) in the area of field crops around Shibin El-Kom. Perfecto and Sediles (1992) found that the abundance of herbivores would be less in the biculture than in the monoculture and the ant foraging activity would be higher in biculture. On the other hand, Hussein and Mikhail (1998) found that herbivores were less abundant when crops form a mosaic pattern of cultivation. In the present study, the different fruit trees were cultivated in one field and formed permanent mosaic pattern of cultivation more complicated than the temporary mosaic pattern of cultivation associated with tuber crops (Hussein and Mikhail, 1998). In the preset investigation, the fruit trees cultivated were harvested either in winter or summer season. This would increase the degree of complexity of the mosaic pattern of cultivation and consequently lead to the reduction of the abundance of herbivores, excluding ant species, and increase ant foraging activity. In the present investigation ants (Formicidae) were considered as herbivores.

Host architecture and leaf morphology were among the possible causes which affect the patterns of herbivore density and abundance (Aguilar and Boecklen 1992). Results of the present investigation are similar to those obtained by Hussein and Mikhail (1998). Host architecture and leaf morphology of fruit trees greatly differed from each other as well as the presence of large

numbers of different weeds. This will lead to decrease the abundance of herbivores, excluding ants, associated with these fruit trees.

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Table (1): Activity density (ind./pitfall trap) of species and/or higher taxa of soil fauna collected from under different fruit trees (A, mango; B, pear; C, apricot; D, apple; E, sour orange; F, fig; G, guava; H, mandarin), with trophic (Troph) groups; Herb, herbivores; Det, detritivores; Carn, carnivores.

Taxa	Troph	A	B	C	D	E	F	G	H
Acarina	Carn	25	35	25	40	20	30	5	15
Araneida	Carn	50	53	165	30	60	60	40	10
Collembola	Det	340	239	135	160	180	390	160	195
Coleoptera									
Anthicidae									
Anthicus sp.	Herb		8		10				
Notoxus sp.	Herb	10	113	5	40		10	5	5
Buprestidae	Herb							5	
Curculionidae									
Sitophilus sp.	Herb		4						
Elateridae	Herb	5	1						
Scarabaeidae									
Pentodon sp.	Det		3						
Other Scarabaeidae			5	5				20	
Staphilinidae	Det		1	5		10			
Tenebrionidae									
Blaps sp.	Det		1						
Zophosis sp.	Det	5	54	10	15	60	70	5	85
Others		15	18	20	10	20		5	
Other Coleoptera			3	10			20		15
Dermaptera									
Labiduriidae	Det				5				
Diptera									
Anthomyiidae	Det		1	5	5	10			
Calliphoridae	Det		3		10				5
Chironomidae	Det	10	8	5	10		10	20	5
Chloropidae	Det								5
Culicidae									
Culex pipiens	Carn	5	1	5	10	10	10	5	5
Dolichopodidae	Carn	15	8	15	5	30	50	5	10

Table (1) Continued.

Taxa	Troph	A	B	C	D	E	F	G	H
Fanniidae	Det		3	30					
Lauxaniidae	Det		1						
Muscidae									
Musca domestica	Det		3	5	5				
Other Muscidae	Det		1	25	10				
Otitidae	Herb							10	
Pipunculidae	Carn		1			10			
Phoridae	Det			25				5	5
Psychodidae	Det		4	10	10				
Sarcophagidae									
Parasarcophaga sp.	Det		4	10					
Other Sarcophagidae	Det		6	10		10			
Sciaridae									
Sciaria sp.	Det	5	10	5		20		15	25
Sepsidae	Det		4						
Sphaeroceridae					25				
Syrphidae									
Syrphus corollae	Herb		1		5				
Tachinidae	Carn	5	1	10		10			
Thereviidae									
Psilocephala freunfeldi	Herb		3						
Tephretidae	Herb	25	69		205	10	70	115	20
Other Diptera		5	34	20			30		5
Embioptera									
Oligotomatidae									
Oligotoma sp.	Herb			20	5				
Tetratembiidae			3						
Heteroptera		5	4	5		10			
Homoptera									
Aphidiidae	Herb	50	40	350	35		30	10	10
Cercopidae	Herb		11			30	10		20
Cicadellidae	Herb	5	35	10	20	70	100	25	5

Table (1) Continued

Taxa	Troph	A	B	C	D	E	F	G	H
Hymenoptera								5	
Braconidae	Carn					10			
Bethyloidea	Carn	5							
Chalcididae	Carn	20	10		5		20	20	10
Formicidae									
Camponotus sp.	Det		1	25	10				
Cardiocondyla sp.	Herb		16		15		50	5	5
Cataglyphes sp.	Herb	10	54		40			20	15
Monomorium sp.	Herb	295	620	220	280	260	340	260	285
Paratrechina sp.	Herb						10		
Pheidole sp.	Herb	1275	2960	1520	3580	820	2110	260	765
Ponera sp.	Herb		1						
Solenopsis sp.	Herb		1						
Other Formicidae			1						
Pompilidae	Carn		1						
Sphecidae	Carn		5						
Vespidae									
Vespa orientalis	Carn	5							
Neuroptera									
Myrmeleontidae larvae	Carn	20	3	5					5
Chrysopidae larvae	Carn		4						
Orthoptera									
Acrididae	Herb	5			5				5
Gryllidae	Herb							5	
Other Orthoptera			9	5	5	10	90		10
Trichoptera	Det		1	15	10	10			
Isopoda	Det	30	26	80	55	50	10	35	25

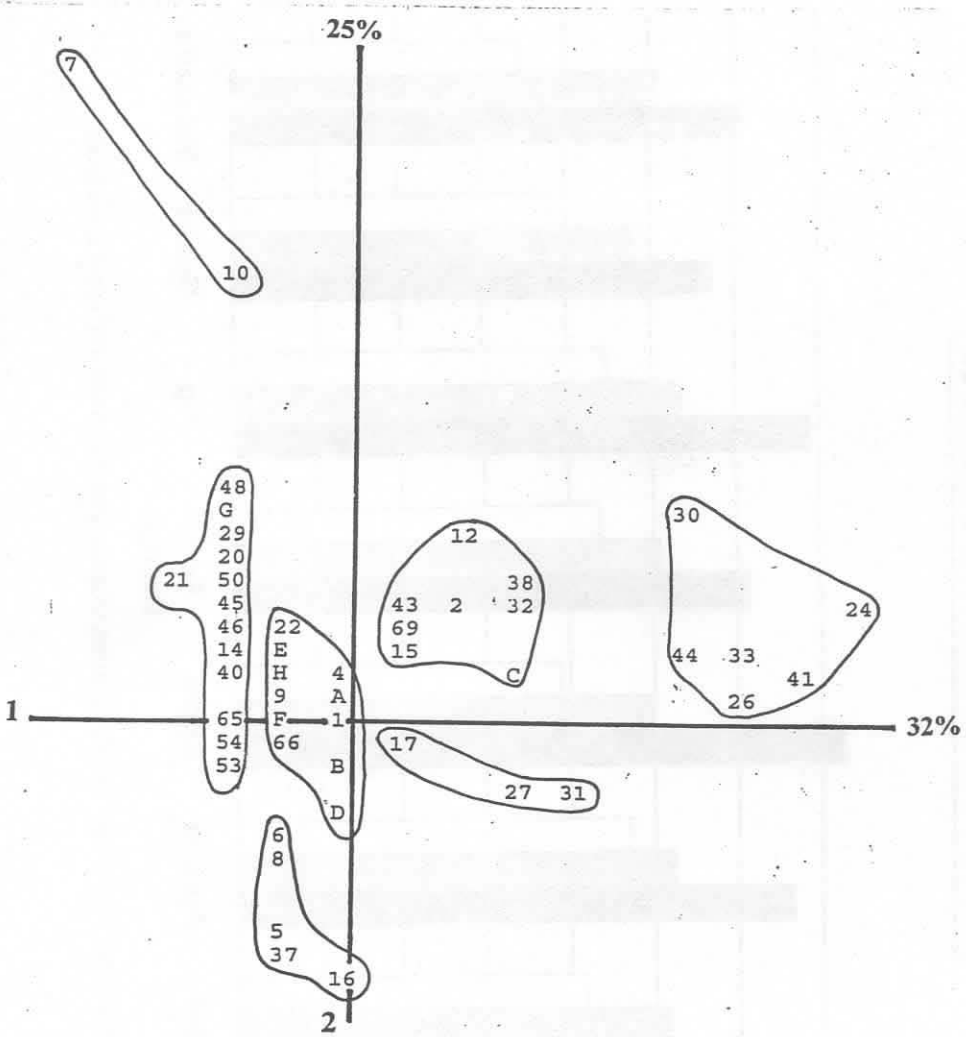

Fig. (1): Graphical representation of the application of CA and AHC methods to data of the activity density of soil fauna species and/or higher taxa . Letters: A-H, fruit trees: A, mango; B, pear; C, apricot; D, apple; E, sour orange; F, fig; G, guava; H, mandarin. Numbers 1-69, species: 1, Acarina; 2, Araneida; 3, Collembola; 4, Coleoptera; 5, *Anthicus* sp.; 6, *Notoxus* sp.; 7, Buprestidae; 8, *Sitophilus* sp.; 9, Elateridae; 10, Scarabaeidae; 11, *Pentodon* sp.; 12, Staphilinidae; 13, *Blaps* sp.; 14, *Zophosis* sp.; 15, other Tenebrionidae; 16, Labiduriidae; 17, Diptera; 18, Anthomyiidae; 19, Calliphoridae; 20, Chironomidae; 21, Chloropidae; 22, *Culex pipiens;* 23, Dolichopodidae; 24, Fanniidae; 25, Lauxaniidae; 26, Muscidae; 27, *Musca domestica;* 28, Otitidae; 29, Pipunculidae; 30, Phoridae; 31, Psychodidae; 32, Sarcophagidae; 33, *Parasarcophaga* sp.; 34, *Sciaria* sp.; 35, Sepsidae; 36, Sphaeroceridae; 37, *Syrphus corollae;* 38, Tachinidae; 39, *Psilocephala freunfeldi;* 40, Tephretidae; 41, *Oligotoma* sp.; 42, Tetratembiidae; 43, Heteroptera; 44, Aphidiidae; 45, Cercopidae; 46, Cicadellidae; 47, Hymenoptera; 48, Braconidae; 49, Bethyloidea; 50, Chalcididae; 51, Formicidae; 52, *Camponotus* sp.; 53, *Cardiocondyla* sp.; 54, *Cataglyphes* sp.; 55, *Monomorium* sp.; 56, *Paratrechina* sp.; 57, *Pheidole* sp.; 58, *Ponera* sp.; 59, *Solenopsis* sp.; 60, Pompilidae; 61, Sphecidae; 62, *Vespa orientalis;* 63, Myrmeleontidae larvae; 64, Chrysopidae larvae; 65, Orthoptera; 66, Acrididae; 67, Gryllidae; 68, Trichoptera; 69, Isopoda. points 28, 47, 67 are with 7, point 34 with G, points 3, 23, 55 with E, points 18, 36 with 15, points 49, 62 with H, point 68 with C, point 52 with 26, point 56 with 54, point 57 with B, point 19 with 6, points 11, 13, 25, 35, 39, 42, 51, 58, 59, 60, 61, 64 with 8, point 36 with 16.

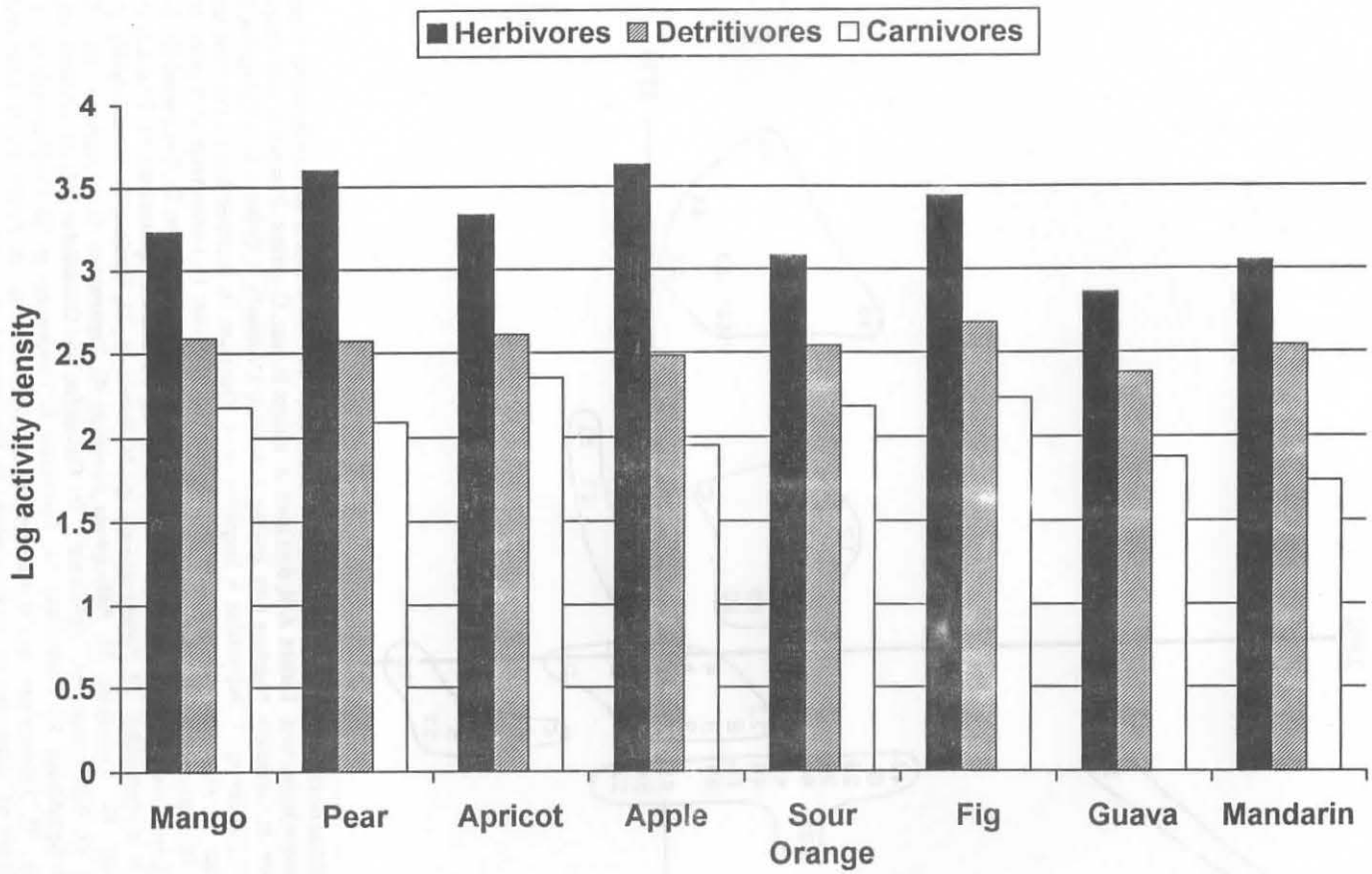

Fig (2) Breakdown of soil fauna into the three main trophic groups under different fruit trees.

المجلة المصرية لعلم الحيوان
المجلد ٣٢ (يونية ١٩٩٩)

المؤتمر السابع
(فبراير ١٩٩٩)

كثافة نشاط حيوانات التربة في الأراضي الزراعية
١ – حيوانات التربة المتوسطة الحجم المصاحبة لأشجار الفواكه المختلطة

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أجري هذا البحث لدراسة كثافة نشاط عشائر حيوانات التربة المصاحبة لأشجار الفواكه المختلطة. جمعت حيوانات التربة باستخدام طريقة مصائد الحفر و ذلك من حديقة فواكه مختلطة (و هي المانجو ، الكمثرى ، المشمش ، التفاح ، النارنج ، التين البرشومي ، الجوافة و اليوسفي) في قرية بياض العرب بمحافظة بني سويف، و كذلك شهريا خلال الفترة بين فبراير و مارس ١٩٩٥. حللت نتائج الدراسة بالطرق الإحصائية المتقدمة مثل التحليل التوافقي و التقسيم الهيراركي. أظهرت الدراسة أن حيوانات التربة السائدة في هذه المنطقة هي أنواع النمل و الكولومبولا كذلك بعض فصائل من رتبة ثنائية الأجنحة. كما أظهرت الدراسة أيضا أن المجموعات الغذائية الثلاث: العاشبات الدقيقة الحجم و آكلات النثار و المفترسات، ممثلة تمثيلا جيدا تحت جميع أشجار الحديقة و أن كثافة نشاط حيوانات التربة كذلك المجموعات الوظيفية تتأثران إلى حد كبير بنمط الزراعة المتداخل (الموازيك) المتبع و الدائم في هذه المنطقة و الذي يؤدي إلى زيادة تنوع حيوانات التربة و الإقلال من الآفات.